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Peak Expiratory Flow as a Predictor for the Effectiveness of Sport for Patients with COPD

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Abstract
This study intended to find simple parameters that were able to determine the increase in physical performance as a result of sport in a group of patients with COPD (lung sport). We regularly investigated pulse, oxygenation and peak expiratory flow in participants with COPD of a "lung sport group", who participated in a structured weekly training program under professional supervision. Ten volunteers (7 females, 3 males, median of age = 69) with COPD (grade II-III) took part in the study.

The relative changes after 3 and 6 months were compared with the values of the first month of exercise. Measurements were carried out before exercise, after stamina training and at the end of the program.

Pulse and oxygenation did not show any changes. However, there was a significant improvement of peak flow after 6 months.

These peak flow changes represent further evidence of positive effects of sport in COPD and provide a parameter which allows the patients themselves to measure and evaluate the success of their physical activity.

Key words: COPD (chronic obstructive pulmonary disease), sport, pulse, oxygenation, peak flow

Introduction

Sport represents one of the evidently tested therapies for COPD leading to an improvement of the patients' quality of life [8, 11, 18].

This prospective study was designed to identify simple parameters that are suitable to establish an improvement in performance as a result of sport in patients with COPD ("lung sport"). The patients took part in a structured training program of an outpatient lung sport group under professional supervision. They practised once a week for 1 h 30 min.

The training program is designed in the following way: It starts with a warm up of about 15 minutes consisting of different kinds of walking as well as the practising of positions and techniques which support breathing. Breathing gymnastics, exercises strengthening the diaphragma like sniffing inhaling, special exhaling techniques and cleaning breathing methods are added for about 10 - 15 minutes.

The next part consists of functional gymnastics with coordination and proprioception training and the strengthening of muscles. It lasts for approximately 15 - 20 minutes. It is followed by muscle strengthening through exercises which improve the stabilisation and combined strength and stamina training which especially emphasises the trunk muscles lasting 15 -20 minutes. The exercises are performed on mats on the floor or with the help of tools like the "thera-tape". Stamina training for about 20 - 30 minutes at the anaerobic threshold including aerobic exercises, step aerobics or dances organised in a stamina circle follows. Stamina supporting games such as hockey and ball games are part of these exercises as well.

The training program finishes with a relaxation exercise including moving-static stretching lasting for about 10 - 15 minutes. The Asian movement techniques Tai Chi and Qigong are sometimes practised too.

Methods

Intention of the Study:

The study intended to identify easily detectable parameters that are able to establish the improvement of performance due to lung sport in patients with COPD. The effects of sport on pulse rate, blood oxygenation and peak exspiratory flow (PEF) of COPD patients were analysed.

Study Design

This prospective study was performed analysing patients of a COPD sport group in Frankfurt/Main (Germany). Ten volunteers (seven women, three men) with COPD grade II-III (according to GOLD) were included in the study after sufficiently long exacerbation-free training with regular measurements. The age of the volunteers was between 42 and 78 years with a median of 69. Changes of pulse rate, blood oxygenation und peak exspiratory flow after three and six months of training were compared with the values at the beginning.

Pulse rate, oxygenation and peak expiratory flow were measured by the patients each time before the training program, after the stamina training and at the end of the program. The participants were given a detailed explanation how to use the measurement technique before the exercises.

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The measurement of oxygenation was performed via pulse-oxymetry using an oxymetre "Nellcor Puritan Bennet NPB 40®". The peak expiratory flow was recorded with the help of a portable device "Vitalograph Peak Flow Meter®".

Analysis

The recorded data were used to evaluate the mean values before starting the training (= base line), after three months and after six months. The relative changes in percent were compared. The ratio of the difference of the mean value after three and six months minus the mean value at the beginning divided by the mean value at the beginning was set in percent. In the analysis the mean value of the beginning was defined to be the base line and was compared with the previously calculated quotients. In order to do so, mean values and standard deviations (SD) were calculated for the latter. A diagram showing the relative changes after three and six months compared with the base line value was created in this way.

Significance for an increase over or a decrease under the base line being equated with zero was accepted in the case that the doubled standard deviation (confidence level 95 %, SD) didn't cut the base line abscissa. Because of the direct presentation of the relative changes including the standard deviations in the diagram any further statistics became unnecessary.

Results

There were no significant changes of pulse rate (Fig. 1) and oxygenation (Fig. 2) after three and six months. However, there were tendencies for an improved peak expiratory flow after three months (Fig. 3). Significantly better PEF-values were measured after 6 months. The median increase of peak expiratory flow was about 5 % after three months and about 10-20 % after six months of training. These effects were most evident during the stamina training and at the end of the program. The individual results (mean values and standard deviations) are summarized in Table 1.

Discussion

Sport is likely to influence the outcome of COPD in a positive way [15, 20]. Continuous moderate training leads to an improved control of symptoms [16]. Cost efficient lung rehabilitation programs improve the prognosis of COPD patients and reduce both the number of hospitalizations and the expenses of the health service [8]. Even short time programs for 3 months could show positive effects because of an increase in functional performance. The patients reported reduced dyspnea and an improved quality of life even in cases where there was no increase of performance [11].

Clinically relevant changes of the 6-minutes-rundistance, the maximum of performance, the peripheral and respiratory muscle strength as well as the quality of life were achieved after training programs of about 6 months [19].

The organization of the training is described in very different ways in literature. Improvements of exercise tolerance, dyspnea and quality of life as a result of exercises performed at home have been described [7]. Consequent private training can lead to increases of performance that are comparable with the results of counselled training programs [3]. However, previous literature stresses the advantages of multi-discipline lung rehabilitation programs under professional control in order to reduce the number and duration of hospitalizations [18]. Supervised, intensive training can increase the kinetic answer of oxygen usage, carbon dioxide production, breathing volume per minute and

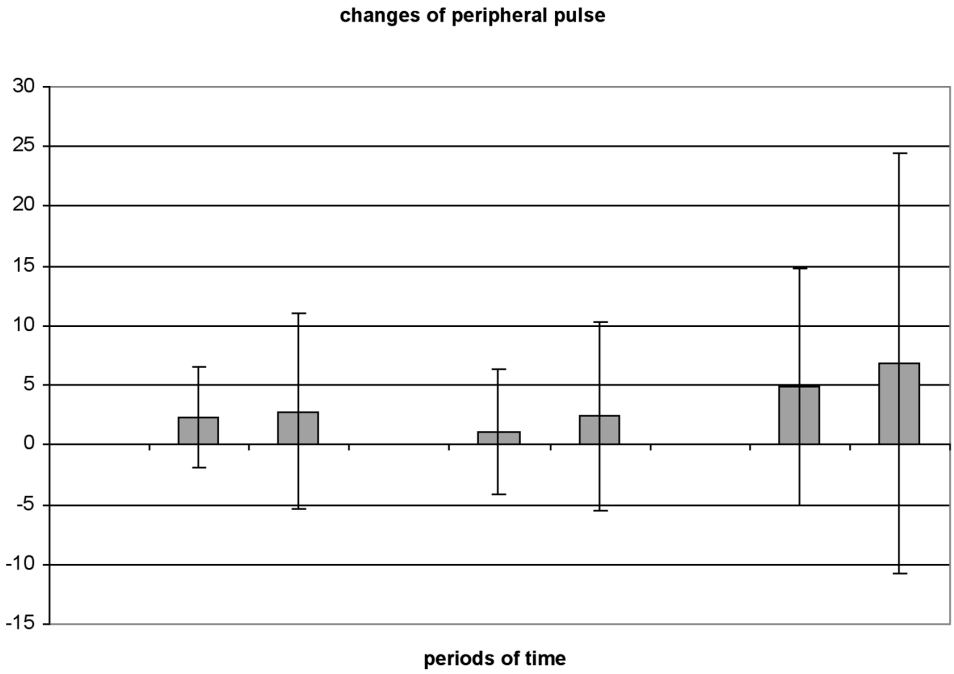

Fig. 1. Changes of peripheral pulse: B = "before training", S = "after stamina training", A = "after training", "3 months" = changes after three months of lung sport in percent, "6 months" = changes after six months of lung sport in percent, T = standard deviation (SD, confidence level 95 %)

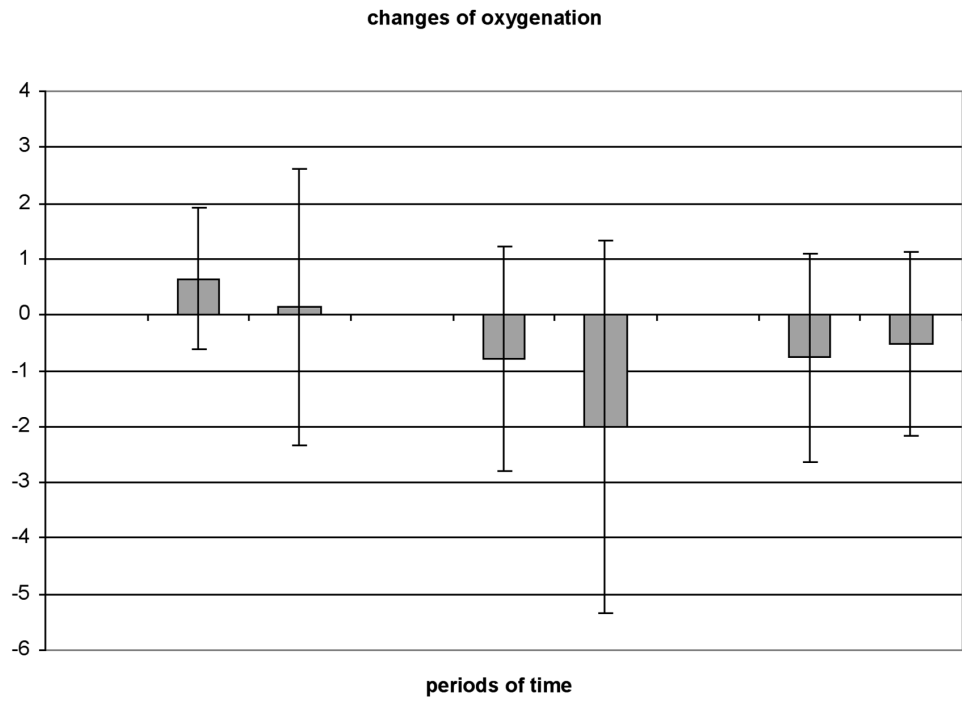

Fig. 2. Changes of oxygenation: B = "before training", S = "after stamina training", A = "after training", "3 months" = changes after three months of lung sport in percent, "6 months" = changes after six months of lung sport in percent, T = standard deviation (SD, confidence level 95 %)

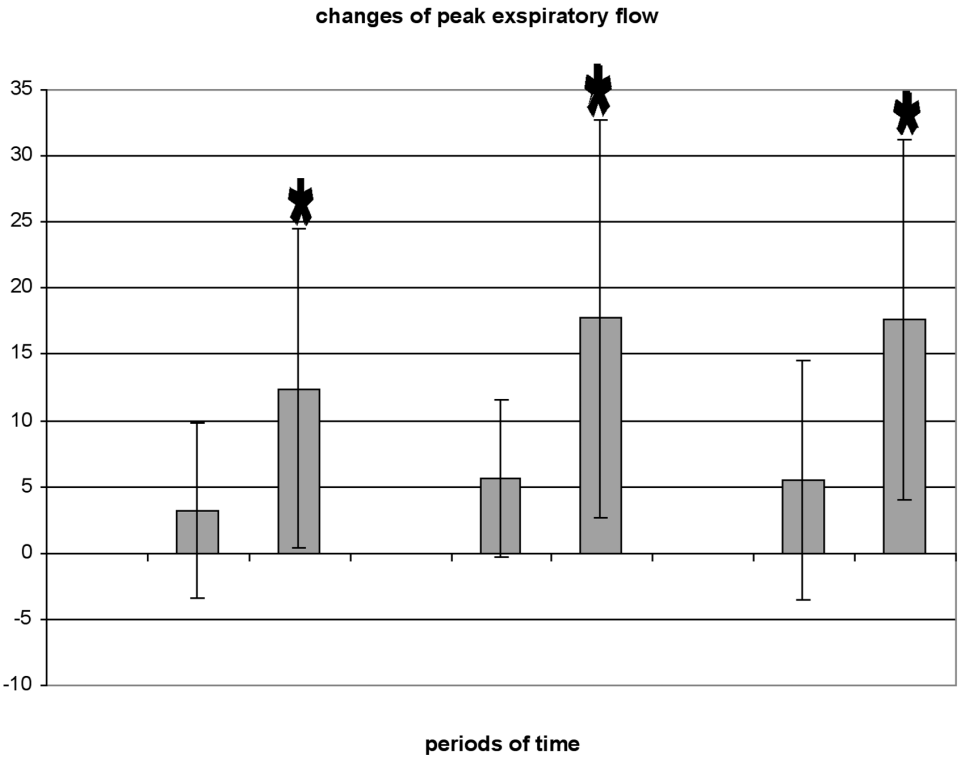

Fig. 3. Changes of peak expiratory flow: B = "before training", S = "after stamina training", A = "after training", "3 months" = changes after three months of lung sport in percent, "6 months" = changes after six months of lung sport in percent, T = standard deviation (SD, confidence level 95 %), * = significance (standard deviation (SD, confidence level 95 %) doesn't cut the base line)

heart rate through moderate exercise to a higher degree than mere individual exercises can do [13].

The reduction of the bone and muscle mass in COPD patients can be partially compensated by training programs. The peripheral muscle strength is an important limiting factor for the physical performance of patients suffering from COPD [5]. An increase of performance contributes to the conservation of bone mass [12].

There is controversial discussion in literature concerning the most effective kind of physical exercise. Improved performance and quality of life were achieved using long-term run programs after a short introductory training at hospital [1]. Stretch gymnastics of the respiratory muscles seem to have a positive effect on breathing [9]. Other authors stress the importance of the decrease of peripheral muscle strength to 70-80 % of a reference population due to COPD and therefore suggest isometric muscle training [17]. Muscle training with weights could modify a weakness induced by the de-conditioning of muscles. Hypox-

Table 1. Mean values and standard deviations of the changes of pulse, oxygenation and peak flow after three and six months

	after 3 months	After 3 months	after 6 months	after 6 months.
	mean value	standard deviation (confidence level 95 %)	mean value	standard deviation (confidence level 95 %)
pulse before training	+ 2.4	4.2	+ 2.8	8.2
pulse after stamina exercises	+ 1.2	5.3	+ 2.5	7.9
pulse after training	+ 4.8	10.0	+ 6.8	17.6
oxygenation before training	+ 0.6	1.3	+ 0.1	2.5
oxygenation before stamina exercises	- 0.8	2.0	-2.0	3.3
oxygenation after training	- 0.8	1.9	- 0.5	1.7
peak flow before training	+ 3.2	6.6	+ 12.4	12.0
peak flow after stamina exercises	+ 5.7	5.9	+ 17.7	15.0
peak flow after training	+ 5.5	9.0	+ 17.6	13.6

emia and insufficient tissue nutrition are unlikely to be the only reasons for deficiency of muscles and skeleton at least in patients suffering from mild grades of COPD [4]. Other authors describe how muscle training as an addition to aerobic exercises leads to a significant increase of muscle strength and muscle mass in patients suffering from COPD, however, it fails to provide an additional improvement of performance and quality of life [2].

Elements of aerobic and stamina training were combined with muscle training in the analysed COPD sport group. The positive effects of both concepts could be combined in this way.

The peak expiratory flow (PEF) is an important indicator for the prognosis quoad vitam for COPD patients that is at least as meaningful as the FEV_1 (forced expiratory volume in one second) [6]. The PEF provides its own prognostic information. It is much more strongly influenced by extra-pulmonary factors such as muscle mass and general vitality than the FEV_1 [6].

Considering these facts the significant increase of peak expiratory flow of the patients after 6 months of training is an undeniable success. This significant increase further suggests that the peak expiratory flow is a suitable marker to determine increased performance resulting from lung sport.

Pulse oxymetry is an easily usable, non-invasive screening method for blood oxygenation [14]. Although its results are not as accurate as the results of an arterial blood gas analysis, it still allows a sufficiently exact estimation [10]. However, the analysed volunteers didn't show any changes of either pulse oxymetry or peripheral pulse rate.

The significantly increased peak flow after 6 months of training suggests a prognostic benefit for the patients. These data suggest that the outcome of COPD can be influenced in a positive way by physical activity. Additionally, the measurement of peak flow provides a parameter for patients which allows them to measure and evaluate their own progress during a lung sport program. In this way the immediately noticeable success of their efforts may lead to a distinct increase in motivation.

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